Acknowledgements

The revised science standards are a result of the contributions of many educators from across the state. Many hours were devoted to research and thoughtful consideration of issues to ensure the standards would reflect rigorous science teaching and opportunities for students to learn important science concepts and procedures with understanding. The Science Standards Revision Committee members represent the many concerned individuals across the state dedicated to their profession and to high quality science education for all South Dakota students. Without their contributions the revision of the science content standards would not have been possible. The South Dakota Department of Education wishes to express appreciation and gratitude to the individuals and the organizations they represent who contributed expertise and time to the revision of South Dakota's Science Content Standards.

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INTRODUCTION/OVERVIEW

PREFACE

These Science Standards are set forth to ensure graduates of South Dakota's public schools have the knowledge, skills, and competencies essential to leading productive, fulfilling, and successful lives as they continue their education, enter the workforce, and assume their civic responsibilities.

In 1997, the South Dakota State Legislature passed SB170 that amended South Dakota Codified Law 13-3-48 to address the issue of challenging state content standards. The adopted amendment reads as follows: "The Secretary of the Department of Education and Cultural Affairs [now the Department of Education] shall prepare and submit for approval of the South Dakota Board of Education academic content standards in language arts, mathematics, social studies, and science for grades one through twelve. Each school district shall adopt and implement clearly defined and measurable course guidelines so as to meet the state academic content standards."

With input from students, parents, teachers, and communities of South Dakota, the Science Standards Revision Committee was charged with revision of the current South Dakota Content Standards and Performance Descriptors. The final document evolved from recent research in best practices in teaching, the No Child Left Behind legislation, experience in classrooms with the existing South Dakota Content Standards, the evolution of published standards from other states, the National Science Education Standards, and National Assessment of Educational Progress (NAEP) Frameworks and Descriptors, numerous professional publications, and lengthy discussions by experienced kindergarten through grade sixteen South Dakota educators.

The content students need to acquire at each grade level is stated explicitly in these standards. With student mastery of this content, South Dakota schools will be competitive with the best educational systems in other states and nations. The standards are comprehensive and specific, they are rigorous, and they represent South Dakota's commitment to excellence. The standards are firm but not unyielding; they will be modified in future years to reflect new research and scholarship.

THE PURPOSE OF THE SOUTH DAKOTA SCIENCE STANDARDS DOCUMENT

The South Dakota Science Standards provide a listing of essential core content to be taught and learned. The standards are designed to guide the planning of instruction and to anchor the assessment of learning from kindergarten through twelfth grade. Performance descriptors bridge the content standards to assessments of the standards, provide information to teachers and students regarding student progress toward mastery of the standards, and specify targets for instruction and learning. The document presents a

starting point for informed dialogue among those dedicated and committed to quality education in South Dakota. By providing a common set of goals and expectations for all students in all schools, this dialogue will be strengthened and enhanced.

KEY CONSIDERATIONS FOR SCIENCE STANDARDS DEVELOPMENT

As students move from kindergarten through grade 12, levels of cognitive demand and complexity of content, skills, and processes increase. New skills emerge and basic skills are subsumed within more advanced skills as students progress through the grades. In particular, mastery of Nature of Science standards and Science, Technology, Environment, and Society standards tends to emerge in later grades. These processes and skills are taught and practiced as Physical, Life, and Earth/Space Science content and skills are acquired. Mastery of most science content standards, however, requires a level of cognitive development not attained by most students until intermediate or middle school grades. Based on information available through national standards work and developmental research, consideration has been given in these standards to the developmental appropriateness of skills required at each grade level. In consideration of developmental appropriateness, the committee has provided emphasis in each grade span as follows.

- Kindergarten through grade 2 standards emphasize building foundational skills in Physical, Life, and Earth/Space Sciences. Teachers guide students through a variety of activities to learn this content.
- Grades 3 through 5 standards continue the emphasis on the Physical, Life, and Earth/Space Science strands with emerging mastery of skills in the Science, Technology, Environment, and Society strand. The Nature of Science strand continues to be represented in the teaching and learning process through a variety of activities applied to Physical, Life, and Earth/Space Science strands.
- Grade 6 standards emphasize an integration of Physical, Life, and Earth/Space Science. Grade 7 standards emphasize Life Science. Grade 8 standards emphasize Earth/Space Science. Nature of Science and Science, Technology, Environment, and Society standards continue to emerge over these grades. (After careful consideration of current research and input from educators throughout the state, the Committee revised former middle school standards to facilitate effective instruction and student mastery.)
- Grades 9 through 12 standards emphasize continuing mastery of the Nature of Science strand and the Science, Technology, Environment, and Society strand in applications to Physical, Life, and Earth/Space Science strands. Content may be embedded in the core classes of Physical Science and Biology or through advanced courses, such as Physics and Chemistry. This content should merge across strands realistically as they do in the natural world.
- The increase in the level of science mastery is a life-long process.

Grade-level standards specify what students should know and be able to do by the end of each grade level while curriculum specifies what teachers will teach. Because standards

are not curriculum, any necessary review embedded in curriculum does not appear from grade-to-grade across grade-level standards. Teachers are charged with introducing skills in earlier grades before mastery is expected and with reviewing skills students will need to use in mastering the grade-level standards.

The Science Standards Revision Committee developed these standards based on several concepts that all teachers and students of science should keep in mind during the learning process:

- Technology is an important tool of science. Access to and application of technology to science is an opportunity that should be available to every South Dakota student.
- Reading and mathematics are basic to the acquisition and communication of scientific knowledge. Emerging mastery of science rests heavily upon students' application of reading and mathematics. All teachers of science should consider themselves teachers of applied reading and mathematics and the specialized uses of these skills in a scientific context.
- Scientists are essentially problem solvers. Every student of science should learn, acquire, and apply problem-solving skills through problem-based learning opportunities in science.
- Science is a process, not a recipe. Students of science need more than a step-by-step set of directions to learn the processes of scientific inquiry.
- Science should be made relevant to students. The application of sciences to everyday life and work should be emphasized (or made clear) to students during the teaching and learning process. The relevance of science to career opportunities should be communicated as a part of science instruction.
- Scientific knowledge is constantly changing and emerging. For this reason, teachers should strive to be current with the constantly emerging advances in science and flexible in adapting their teaching to these new advances. In this context, teachers need to take advantage of the teachable moments that evolving scientific knowledge and current events provide.
- The state of South Dakota offers a treasure-trove of opportunities for observing science in the natural world and in the evolving applications of science to industry and society. Teachers should take advantage of these opportunities to make science real and present to students. (See the Resource list in Appendix C for a few ideas.)
- Science is participatory, not passive knowledge acquisition. Laboratory opportunities for experimenting with and experiencing science should be universally available to every South Dakota student.
- Teaching and learning in a standards-based system is not a textbook-driven process. Textbooks are tools that, when used appropriately, enhance teaching and learning by providing instructional materials relevant to the specified standards.
- While standards are the core that all students should learn and master, teachers will expand upon these standards and introduce related topics to students in the course of instruction.

Teachers and researchers have learned that in order for students to demonstrate mastery of skills specified in the standards on summative (end-of-year) assessments, **teachers**

must teach and students must learn at a level of fluency that exceeds the apparent expectations of the grade-level standard. For this reason, teachers must be knowledgeable and talented in teaching the content, skills, and processes described in standards immediately below and above as well as at their own grade-level assignment.

FORMAT OF THE STANDARDS DOCUMENT

Standards

The standards are the targets all students need to meet at the proficient level by the end of each grade level. The standards are presented in two formats. The first format organizes the standards by grade level so a student, parent, classroom teacher, administrator, or local school board member can quickly review what learning is expected at each specific grade. The Bloom's Taxonomy level of cognitive challenge is listed in the standards document to make clear the level at which each standard should be assessed.

At grades 9 through 12, schools teach skills and courses in a variety of configurations to accommodate students and school personnel, especially in rural settings. For this reason, the grade-level standards are grouped into core and advanced standards. The core high school standards all students are expected to meet by graduation include topics of physical science and biology with core standards from earth science applied in these courses. The advanced high school standards apply to students who have completed the core standards and choose an advanced science curriculum. Students who plan to attend post-secondary educational institutions should complete science courses reflected in the advanced standards. However, these advanced science standards may also be incorporated into elective science courses that all students should have the opportunity to learn and master.

All standards in each grade level and the core standards for high school need to be met at the proficient level by the time students are tested for these skills on the state assessments. For early grades not assessed on the state assessments, students need to master the standards at each grade level in order to be adequately prepared to meet the next grade-level standards and subsequently, to achieve the proficient level at the grade levels tested.

The standards are also provided in a side-by-side format so the alignment of standards from grade-to-grade is immediately apparent. This section of the document contains content goals, indicators, grade-level standards, and performance descriptors. Each has a role in shaping the expected outcomes for South Dakota students.

- **Strands** are the broad conceptual content areas that define science. They are: Nature of Science, Physical Science, Life Science, Earth/Space Science, and Science, Technology, Environment, and Society.
- **Indicators** are the common threads of a strand that represent expected outcomes for all students preparing to graduate from South Dakota schools.

- **Grade-level content standards** represent expected outcomes for students completing each grade level.
- **Grade-level supporting skills** represent enabling skills students may need to be taught in order to achieve the standards. Those identified by a (•) bullet are enablers to the specific grade-level standard. Those identified by a checkmark (√) are enablers to the next higher grade-level standards that are related to current grade-level standards and thus may be introduced at an earlier time.
- **Examples** represent some possible materials, activities, or sub-skills classroom instructors could use in teaching the standards or supporting skills. Examples are not provided where the meaning of the standard should be evident to the reader. While the intention of providing examples is to clarify what is intended in terms of the complexity and level of challenge of the standard, these examples do not represent actual test items that will appear on the assessment.

Performance Descriptors

The performance descriptors are organized into proficiency levels. These proficiency levels describe the content and processes that a student at a given proficiency level would be expected to know, demonstrate, or perform. To identify increasing proficiency in science, the levels are labeled as follows:

- **Advanced:** A student performing at the advanced level exceeds expectations for that grade level. The student is able to perform the content standards for the grade at a high level of difficulty, complexity, or fluency beyond that specified by the grade-level standards.
- **Proficient:** A student performing at the proficient level meets expectations for that grade level. The student is able to perform the content standards for the grade at the level of difficulty, complexity, or fluency specified by the grade-level standards.
- **Basic:** A student performing at the basic level performs below expectations for that grade level. The student is able to perform some of the content standards for the grade below the level of difficulty, complexity, or fluency specified by the grade-level standards.

A student performing below the basic level is unable to perform the content standards for the grade. Therefore, no description is provided below the basic level.

ADDITIONAL RESOURCES

Since this document uses appropriate science terminology, a reader may occasionally encounter an unfamiliar term. In order to assist the reader with terminology used in this document, a **glossary** has been included with specific definitions to clarify intended meaning.

In addition, a **resource list** is provided in the appendix as a sampling of possible information sources. Because new resources are constantly becoming available, this list is intended to be neither an exhaustive nor a required list of resources.

A MESSAGE TO TEACHERS, PRINCIPALS, SUPERINTENDENTS, AND OTHERS WHO WILL USE THE DOCUMENT

The Science Standards Committee was made up of a group of K-16 teachers who collaborated to establish a starting point for reaching South Dakota's goal: each student performing to at least the proficient level.

A set of standards is simply a place to begin—it lays the foundation for measurable, consistent, high-level student learning; however, teachers must consider the needs of their individual students and select the methods that will work best for their classrooms. Examples and lists of supporting skills have been provided to clarify but not limit the meaning of the standards. ***The curriculum of each district must provide students with rigor and topics beyond those of the standards in order to ensure mastery.***

Clearly, there is more to teaching and learning than these standards. Adjustments will need to be made for those students who exceed the standards and for those who cannot easily meet them. The standards are a starting point in creating an environment where students can learn to live and thrive in a constantly changing, increasingly complex world.

IMPORTANT NOTE TO TEACHERS: Not every supporting skill presented in this document needs to be taught in order for students to master the associated standard. This is also true for the examples that appear in this document. Supporting skills and examples are provided only to illustrate the standard and are not designed as requirements to be taught.

CONCLUSION

South Dakota's students must continue to progress in their mastery of science. They will need a wide repertoire of science concepts, applications, and skills in order to be successful learners, workers, and citizens. The ultimate purpose of the Science Content Standards is to ensure that all students are offered opportunities, encouragement, and experiences to develop the understanding of science needed to pursue lifelong goals.

Science Standards

K-12

Goals and Indicators

NATURE OF SCIENCE STANDARDS

Goal 1: Students will explore, evaluate, and communicate personal and scientific investigations to understand the nature of science.

RATIONALE:

The nature of science goal emphasizes those "processes of science" that should integrate with scientific knowledge to develop an understanding of how science works. Science involves a systematic approach to information gathering and problem solving through processes such as inquiry, observation, data analysis, experimentation, communication, and collaboration. Students use scientific inquiry to ask questions, plan and conduct investigations, use appropriate tools and techniques to gather data, think critically and logically about relationships between evidence and explanations, construct and analyze alternative explanations, and communicate scientific arguments. Through these processes, scientific knowledge is studied, tested, and increased over time.

Indicator 1: Understand the nature and origin of scientific knowledge.

Indicator 2: Apply the skills necessary to conduct scientific investigations.

PHYSICAL SCIENCE STANDARDS

Goal 2: Students will use appropriate scientific models to describe and quantify the nature and interactions of matter and energy.

RATIONALE:

Physical science is concerned with matter and energy, and the interactions between the two. Students begin the study of the physical world by learning about the properties of objects and materials, the position and motion of objects, light, heat, electricity, and magnetism. Understanding changes of properties in matter, motions, forces, and transfer of energy provide a basis for learning about the structure of atoms, structure of matter, chemical reactions, conservation of energy, and the interactions of energy and matter. The science facts, concepts, principles, theories, and models related to physical science that are important for all students to know, understand, and use are the focus of the standards for this goal.

Indicator 1: Describe structures and properties of, and changes in, matter.

Indicator 2: Analyze forces, their forms, and their effects on motions.

Indicator 3: Analyze interactions of energy and matter.

LIFE SCIENCE STANDARDS

Goal 3: Students will describe structures and attributes of living things, processes of life, and interaction with each other and the environment.

RATIONALE:

The life science standards emphasize a complex understanding of the characteristics and diversity of organisms and the interaction of organisms with their environment. Students begin by learning about the characteristics and life cycles of organisms and the interaction between organisms and various environments. Students develop an understanding of the relationship between structure and function in living systems, reproduction and heredity, regulation and behavior, populations and ecosystems, and diversity and adaptation of organisms. This knowledge provides a foundation for learning more complex concepts related to the structures and functions of the cell, heredity, behavior and interdependence of organisms, and the organization of living systems. Life science facts, concepts, principles, theories, and models that are important for all students to know, understand, and use are the focus of these standards.

Indicator 1: ***Understand the fundamental structures, functions, classifications, and mechanisms found in living things.***

Indicator 2: ***Analyze various patterns and products of natural and induced biological change.***

Indicator 3: ***Analyze how organisms are linked to one another and the environment.***

EARTH/SPACE SCIENCE STANDARDS

Goal 4: Students will analyze the composition, formative processes, and history of the universe, solar system, and Earth.

RATIONALE:

Earth/space science focuses on the processes and interactions of the universe, solar system, and Earth. Investigations of Earth focus on interacting and dynamic systems including the lithosphere, the hydrosphere, the atmosphere, and the biosphere. Each system is composed of unique characteristics which interact and interrelate to form a single, universal system. Forces acting throughout the solar system and the universe influence all bodies in space, including Earth. Studying the universe enhances our understanding of Earth and its place in the universe.

Indicator 1: ***Analyze the various structures and processes of the Earth system.***

Indicator 2: ***Analyze essential principles and ideas about the composition and structure of the universe.***

SCIENCE, TECHNOLOGY, ENVIRONMENT, AND SOCIETY STANDARDS

Goal 5: Students will identify and evaluate the relationships and ethical implications of science upon technology, environment, and society.

RATIONALE:

The interrelationships among science, technology, the environment, and society establish connections between the natural and designed worlds and provide students with opportunities to develop decision-making abilities. Technology is essential to science because it enhances scientific observations of phenomena and provides tools for investigations, inquiry, and analysis. Science and technology provide the solutions to many human problems; however, solutions may have unintended consequences. An important purpose of science education is to give students a means to understand and act on personal and social issues. These standards help students develop decision-making skills through a better understanding of the costs, benefits, risks, and constraints of scientific problem solving. These standards emphasize abilities associated with the process of design and fundamental understandings about the enterprise of science and its various linkages with technology.

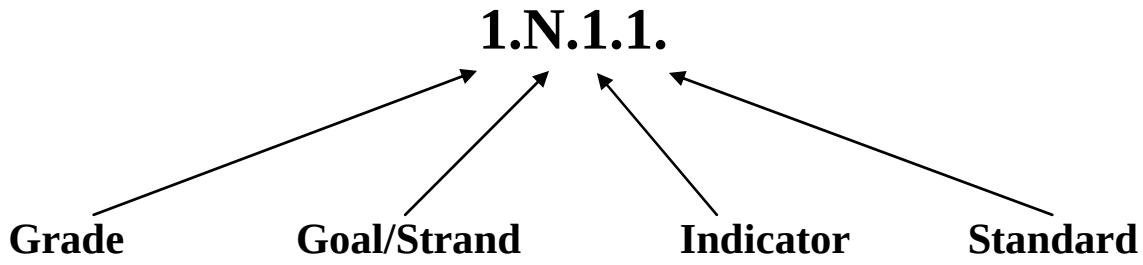
Indicator 1: ***Analyze various implications/effects of scientific advancement within the environment and society.***

Indicator 2: ***Analyze the relationships/interactions among science, technology, environment, and society.***

Guide to the Numbering and Symbol System

Used in the Document

Standards are coded to cross-reference grades, goals/strands, indicators, and standards.



Grade refers to the grade level at which the standards are to be mastered by students.

Goal or Strand refers to the major area of science (e.g., physical science, life science, earth and space science) this group of standards address. These strands are coded:

N for Nature of Science

P for Physical Science

L for Life Science

E for Earth and Space Science

S for Science, Technology, Environment, and Society

Indicator refers to the number of the indicator for this goal or strand. Each goal has one or more related indicators that describe key aspects of the goal.

Standard refers to the number of the grade-level standard for the indicator. Each indicator has one or more grade-level standard(s) that describes what students will know and be able to do related to the indicator at the specific grade level.

Examples in bold type are directly related and aligned to the level of the standard. These examples represent the level of difficulty intended in the grade-level standard and possible materials, activities, or sub-skills classroom instructors could use in teaching the standards.

Grade-level supporting skills represent enabling skills students may need to be taught in order to achieve the standards.

(•) Bullets represent enabling skills to the current grade-level standard students may need to be taught in order to achieve the standards.

(√) Checkmarks are enabling skills to the next higher grade-level standards that are related to current grade-level standards and thus may be introduced at an earlier time.

Examples that are NOT in bold type are related and aligned to the level of the bullets/supporting skills and checkmarks. These examples represent the level of difficulty intended in the grade-level standard. They represent some possible materials, activities, or sub-skills classroom instructors could use in teaching the supporting skills.